

6. Title: Studies of Malabsorption. IV. The Effect of Tropical Climates on the Normal American Intestine.

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Objective Since August 1966 a continuing study of the intestinal function and symptomatology of 32 Peace Corps Volunteers stationed in Thailand has been undertaken. The purpose of this investigation is to answer these questions:

1. Will healthy North American individuals coming to Thailand develop intestinal absorption and histologic patterns characteristic of normal Thai people viz: nonspecific jejunal mucosal abnormality, lactose malabsorption, and normal xylose absorption?

2. What is the frequency of subclinical and clinical malabsorption of Americans living in Thailand under local condition?

Description With the full and gratifying cooperation of the Peace Corps Officials in Thailand, a group of Volunteers were approached in 1966 by SMRL to participate as subjects in a study of intestinal function while they worked in Thailand. The studies to be undertaken (see below) were explained to the Volunteers within 48 hours of arrival in Bangkok from abroad. Explanations went into considerable detail, including actual study techniques, and incidence of risk involved. 34 individuals volunteered; 32 have remained in Thailand.

Within the first few days in Thailand the following studies were performed on the subjects:

- History and physical examination
- Body weight
- Chest X-ray
- Complete blood count
- Urinalysis
- VDRL
- D-Xylose tolerance test (25 gram dose)
- Lactose tolerance test (1.5 gram/Kg body weight)
- Schilling test of vitamin B₁₂ absorption (with intrinsic factor given)
- Serum β -carotene, cholesterol, Vitamin A, folic acid, total protein, protein electrophoresis and fasting blood sugar.

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Jejunal biopsy (Crosby capsule)

a. Histologic examination

b. Disaccharidase assays

Stool examination for ova and parasites.

Thereafter the individuals began their duties at towns and villages throughout Thailand. A questionnaire regarding incidence of intestinal symptoms, dietary habits, general health and drug use was sent to every volunteer monthly and returned filled in. In 1967, 10 months after arrival in Thailand, the Volunteers all came to Bangkok for their annual Peace Corps physical examination. At that time they were studied again exactly as before. In 1968, at the time of their final Peace Corps physical examination, they will again be studied by our group in the same way.

Progress The 1966 (baseline) and 1967 studies are now nearly complete.

Symptoms Study subjects were interviewed in detail regarding intestinal and other symptoms experienced while in Thailand for 10 months. The information obtained corresponded closely to that abstracted from the questionnaires returned by the individual subjects. Several subjects reported no diarrhea or intestinal problems at all. Most had diarrhea periodically, usually every 3-6 weeks, and often associated with cramps in the lower abdomen. Nausea, vomiting and melena were conspicuously absent from most histories. Most subjects noted that diarrhea occurred more often in the morning than at other times during the day, and more often during field trips than when they were at home. The usual form of treatment for diarrhea was Polymagma or Kaopectate, provided by the Peace Corps in a medical kit given the volunteer. There was very little use of antibiotics for diarrhea, although tetracycline is included in the medical kit. Several Volunteers used no anti-diarrheal treatment at all. Acute diarrheas rarely lasted longer than two days, and were reported as a reason for missing work by only four individuals.

Three subjects had more diarrhea than the others. One patient, subject #23 below, had sustained explosive movements for days at a time, and stool frequency for 5 months, but gave no other history suggestive of tropical sprue*. Two additional subjects had acute diarrheal attacks each week, but otherwise felt well.

Other symptoms reported by Volunteers included fatigue and skin trouble as the most common. Weight loss was suspected by at least half of the group. One individual had recurrent, chloroquine-resistant malaria.

Physical Examination All but 4 subjects lost weight, from 2-29 pounds. Physical findings were very few, mainly skin disorders. One subject had a large liver with normal liver function tests. Splenomegaly was not noted. Signs of vitamin deficiency were not noted. Subject #23 had a benign sessile polyp excised from the rectum. He had lost eight pounds but had no other physical findings of note.

Laboratory examination Only two individuals were anemic after 10 months in Thailand, and one was a menstruating female. There was no evidence of red cell macrocytosis in these individuals. Aside from minimal changes in red cell morphology in seven subjects and moderate eosinophilia in 10 subjects, hematologic examinations were normal. Data are shown in Table 19.

D-xylose tolerance tests were normal in all but one person in 1966. By 1967, 25 individuals absorbed less D-xylose than they had in 1966, and of these, 14 were below 5 grams excretion. Three individuals had markedly depressed xylose absorption, including subject #23 with chronic diarrhea.

Lactose tolerance test data showed that among the 28 individuals studied both in 1966 and 1967, 21 absorbed less lactose in the latter year. Completely flat lactose tolerance tests were common after 10

* This individual was placed on folic acid therapy, 5 mgm daily by mouth, with subsequent improvement in symptoms and xylose absorption.

months in Thailand (6 subjects) but absent from the study group in 1966 at the time of initial evaluation. Six individuals did, however, have low lactose absorption in 1966, a percentage (20%) corresponding to that in most studies of normal Americans and Europeans outside of the tropics.

Vitamin B₁₂ absorption was normal in all but one subject on arrival in Thailand. Ten months later, four were abnormal, not including the subject abnormal on arrival. All four of these subjects had low xylose absorption. Subject #23 had both the lowest xylose and the lowest B₁₂ absorption, and the most symptoms.

Serum carotene, cholesterol and proteins were studied in 1966 and 1967 in 16 subjects. There was a general decrease in carotene, albumin, alpha-1, and beta globulins in the 10 months period, but gamma globulins were slightly increased. Serum folic acid values are not currently available. Cholesterol levels stayed the same for the group as a whole.

Mucosal biopsies were obtained from the jejunum in 27 individuals in 1966 on arrival. Sixteen were histologically normal. The others showed mild nonspecific abnormalities. The biopsies in 1967 were abnormal in the majority, only five being normal. Changes included eosinophilia of mucosa, plasma cell and mononuclear cell infiltration, decrease in villus/crypt ratio and edema. Several biopsies showed acute mucosal inflammation (edema and polymorphonuclear infiltration). Subject #23 had a marked villous atrophy, very heavy cellular infiltration and edema. Subject #32 had acute inflammatory changes; this individual was the patient with falciparum malaria.

Disaccharidase assays of mucosal biopsies obtained in 1966 were performed at SMRL. These data are largely worthless due to technical error. Disaccharidase assays in 1967 were properly performed (by Dr. Pearl Anderson, Department of Medicine, WRAIR) and are shown in Tables 20 and 21. The data indicate low values for maltase, sucrase and lactase, the last being most depressed. This holds for enzyme activities base both on wet weight and protein content of mucosa. Correlations of lactase levels to lactose absorptive capacity are not complete, and await 1968 studies.

Studies at the time of terminal physical examination in 1968 are currently being performed, and data are still too few to report here.

Summary During the first ten months in Thailand a group of 32 Peace Corps Volunteer, normal on arrival as regards gastrointestinal structure and function, have developed a variety of abnormalities. 19% (6 individuals) definitely have xylose malabsorption, while an additional 22% (7 individuals) are borderline in this regard. 12% (4 subjects) have developed Vitamin B₁₂ malabsorption. There is a tendency in the group as a whole to absorb less lactose than on arrival, and mucosal disaccharidase values are generally low, especially lactase. Nonspecific abnormalities in the jejunal mucosa have developed in most individuals. All of these changes have occurred in a group of people who, with only one and perhaps two more exceptions, have not experienced sufficient gastrointestinal symptoms to miss work or even consult a physician. Studies are continuing into 1968 to see how these volunteers fare in the second year in Thailand.

Table 19. Physical and Laboratory Examinations of Peace Corps Volunteers

Number	Weight (Pounds)	Urine Xylose (Gms excreted in 5 hours)		Blood Xylose (mgm% at 2 hours)		Schilling (% excretion of dose 24 hrs)	Lactose (max rise blood glucosemgm %)		Stool Parasites	Eos % of WBC	Albumin Gms %	Globulin Gms %		Cholesterol		Carotene				
		1966	1967	1966	1967	1966	1967	1966	1967	1966	1967	1966	1967	1966	1967	1966	1967			
1	159.5	149.5	5.3	5.5	27.2	38.8	11.7	6.7	66	40	None	1	3.6		3.1	143	58.1			
2	170	157	6.4	4.9	32	27.4	23	10	69	23	E. Coli	1	4.3		2.9	188	70.2			
3	169.5	167	6.2	5.2	26.3	29.5	23	32	26	46	None	5	3.8		2.9	163	96.8			
4	154	149.5	5.7	4.5	29.3	28.9	27	0.55*	57	39	None	0	4.0		3.1	167	100.4			
5	194	190	8.0	7.03	31.5	28.2	24	26.5	71	41	None	1	4.2		2.6	158	98.0			
6	167	138	7.8	6.2	31.5	35.1	24	14.8	—	12	None	2	4.2		2.5	127	67.8			
7	177	160	7.9	4.75	30.7	28.0	26	22.2*	65	57	None	5	3.9		2.7	168	113.7			
8	149	146.5	8.1	7.7	38.1	33.5	16	15.6	76	35	None	1	3.9		2.8	194	73.8			
9	126	121	6.1	2.47	43.8	24.7	31	12.5*	60	29	None	1	4.1		3.3	213	71.4			
10	156	158	5.4	6.09	21.9	24.2	1.3	22.2*	91	93	None	1	3.8		2.7	197	94.4			
11	135	124.5	6.2	5.0	37.5	35.5	—	23.8*	—	0	None	0	4.3		2.9	190	177.9			
12	140	132	6.4	2.59	40.6	17.7	—	3.8*	—	21	None	1	3.9		2.6	193	111.3			
13	135	132.5	6.5	6.6	36.3	54.4	—	23.2*	—	51	None	1	4.1		3.0	219	131.9			
15	160	155	7.4	6.86	27.7	34.3	23	12*	38	37	None	10	3.8		3.0	210	50.9			
16	150	147	6.2	6.37	30.7	43.1	22	18	44	38	E. Histolytica	8	4.4	3.7	2.9	2.5	176	157	123	73.8
17	139	137	8.5	5.7	33.7	28.7	29	7.8	27	45	None	1	4.3	4.4	2.6	2.4	174	214	101	192.4
18	180	170	5.2	4.25	25.2	27.0	9	12.2*	7	0	G. Lamblia	1	4.0	4.2	2.7	2.9	170	203	86	93.2
19	159	151	9.2	6.26	35.6	34.8	21	11.3*	66	49	E. Coli	5	4.2	4.9	1.9	1.6	138	153	82	73.8
20	125		2.2		13.9		10		3								202		104	
21	125	126.5	6.5	4.91	29.7	29.7	22	12.1*	47	28	None	5	4.1	3.9	2.7	3.0		185		70.2
22	164	155.5	6.8	4.65	29.7	21.7	10	21.5*	24	51	None	1	4.0	3.7	2.3	1.9		202		81.1
23	149	141	7.5	1.16	31.2	10.8	14	0.38*	17	0	None	1	4.0	3.9	2.3	2.1	178	151	103	33.9
24	130	127	5.3	3.29	28.7	29.9	21	17.5*	13	0	E. Coli	3	4.5	4.1	2.4	2.8	236	177	103	33.9
25	159	156	5.4	4.82	21.8	21.3	26	12.5*	17	7	None	3	4.0	4.1	2.9	2.4	152	172	116	124.6
26	175	166	5.6	5.52	26.2	26.8	25	14.2*	26	50	None	2	4.1	4.2	2.5	2.7	202	177	93	50.8
27	150	134	6.3	7.37	30.7	42.0	22	28	15	12	None	8	4.1	4.0	2.8	2.9	233	222	123	127.1
28	160	160	8.1	6.49	35.6	39.6	29	22.2	67	58	G. Lamblia	3	3.9	3.3	2.5	2.5	170	173	91	87.1
29	175	173	6.9	4.5	24.8	18.5	12	12.7*	4	0	None	1	3.9	3.7	2.8	3.3	136	154	87	81.1
30	160	149	15.0	3.39	38.6	20.4	16	0.7*	40	23	None	0	3.8	4.0	2.7	3.0	144	173	113	69.0
31	164	149	4.6	4.6	22.3	26.9	—	25*	36	12	None	6	4.0	3.6	2.5	2.7	129	163	65	99.2
32	135	128	5.4	3.4	24.8	23.9	17	14.2*	21	0	F. malaria	2	4.3	3.9	2.7	3.5	138	133	75	49.6
33	149	149	7.6	8.51	32.7	50.4	10	25*	47	78	Hookworm	2	4.0	4.3	2.7	2.1	113	140	82	95.6
34	139	136	6.2	5.44	27.7	31.8	15	34	36	58	Whipworm	6	3.7	4.3	2.8	2.5	170	180	101	70.2
		Mean	Mean			Mean	Mean													
		6.7	5.0			19.7	17.4													

* average 10 min and 100 min reading

Table 20. Units per gram Wet Weight Jejunal Mucosa (Peace Corps Volunteers)

Volunteer No.	Maltase	Sucrase	Lactase	Cellobiase
1	26.60	8.81	1.69	0.35
2	36.49	11.51	2.48	0.50
3	15.77	4.50	1.20	0.24
4	0.86	0.00	0.04	0.00
5	3.11	0.76	0.52	0.12
7	40.71	11.11	1.67	0.15
8	15.63	4.79	2.88	0.58
9	2.15	0.78	0.00	0.00
11	6.33	2.26	0.07	0.00
12	17.36	4.80	1.70	0.32
16	35.32	10.25	3.56	0.63
17	22.84	5.98	3.01	0.75
18	20.75	5.77	0.21	0.00
19	34.31	10.64	6.29	1.22
21	28.95	9.08	2.28	0.44
22	29.10	9.30	5.39	1.08
23	10.43	2.84	0.09	0.02
24	2.99	0.83	0.08	0.00
25	7.15	2.39	0.02	0.00
26	28.39	8.48	4.19	0.81
27	18.84	5.67	0.46	0.07
28	6.28	1.52	0.69	0.26
29	14.62	3.98	0.20	0.09
30	26.16	6.63	1.77	0.30
31	22.19	7.03	0.84	0.00
32	26.66	8.93	0.21	0.00
33	14.27	5.04	3.04	0.61
34	26.12	7.79	5.10	1.19

Normal values (excluding cellobiase)

	Mean	Range	} Units per gram wet weight
Lactase	7.4	0.9 — 28.1	
Maltase	48.7	5.0 — 138.1	
Sucrase	16.5	2.8 — 58.2	

Unit = micromoles disaccharide hydrolyzed per minute at 37 C.

These assays were performed by Dr. Pearl Anderson, Division of Medicine, WRAIR

Table 21. Units per gram Protein Jejunal Mucosa (Peace Corps Volunteers)

Volunteer No.	Maltase	Sucrase	Lactase	Cellobiase
1	370.8	122.78	23.61	4.90
2	365.6	115.30	24.88	5.01
3	206.0	58.76	15.73	3.11
4	14.53	0.00	0.69	0.00
5	108.5	26.43	17.99	4.10
7	271.4	74.08	11.10	1.00
8	197.4	60.50	36.34	7.28
9	112.0	40.97	0.00	0.00
11	285.1	101.7	3.02	0.00
12	139.7	38.58	13.70	2.60
16	277.6	80.53	27.99	4.97
17	553.4	144.8	72.94	18.09
18	218.4	60.73	2.22	0.00
19	246.7	76.51	45.19	8.78
21	341.8	107.23	26.93	5.22
22	231.4	73.93	42.86	8.56
23	166.4	45.38	1.38	0.34
24	61.55	17.03	1.65	0.00
25	238.5	79.81	0.82	0.00
26	358.1	107.1	52.88	10.22
27	225.7	67.98	5.54	0.82
28	134.5	32.62	14.66	5.50
29	174.0	47.33	2.35	1.04
30	205.6	52.06	13.89	2.37
31	246.6	78.14	9.31	0.00
32	147.1	49.25	1.17	0.00
33	483.3	170.8	102.9	20.57
34	277.9	82.85	54.24	12.66

Normal values (excluding cellobiase)

	Mean	Range	} Units per gram protein
Lactase	49	4 — 149	
Maltase	335	52 — 816	
Sucrase	104	21 — 247	

Unit = micromoles disaccharide hydrolyzed per minute at 37 C.

These assays were performed by Dr. Pearl Anderson, Division of Medicine, WRAIR